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Investigation on Quality Evaluation of Spray Dried Beetroot Powder

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Abstract

The present investigation aimed to investigate the effects of varying concentration of soluble starch with different temperature on the physicochemical characteristics and sensory evaluation results of beetroot juice powder under different spay drying conditions including temperature and concentration of carrier agents with feed flow rate 10ml/minute. Increasing carrier agent concentration caused increases in the L value 70.75.to 71.70 and pH along with decreases in the moisture content. In sensory evaluation, as the concentration of the carrier agents increased, the overall acceptability received a higher preference rating.*
Keywords: *Beetroot, spray drying, soluble starch, Betalin*

Introduction

Beetroot (*Beta vulgaris* L.) belongs to chenopodiacae family is a seasonal vegetable is mainly grown in nutritional kitchen garden as well as on commercial scale. Beetroot possess fleshy enlarged roots, which has nutritional, culinary, medicinal and industrial significance. It's contain 7.96%sugar, 9.96% carbohydrates, 1.68% protein and 6mg of vitamin C per hundred gram of pulp. It is also an excellent source of calcium, magnesium, Iron, copper, phosphorus and sodium. Its low caloric density is suitable for calorie conscious people. Increase shelf life and availability of beetroot round the year it converted into beetroot powder. From beetroot powder, juice can be prepared instantly whenever required. Beetroot powder is reported to have medicinal properties, particularly to improve digestion and blood quality. It detoxify the body faster and better than almost any other vegetable juice on earth[8].

Now a day there is growing interest among the people the use of natural food colors, because synthetic dyes are becoming more critical assessed by the consumer. To improve the red color of tomato pastes, sauces, jams, jellies, ice creams, sweets and breakfast cereals, fresh beetroot or beet powder or extracted pigments are used[5].

Spray drying of beetroot juice may be a good alternative to use due to its health loving components available throughout the season. Spray- dried powders have good reconstitution characteristics, low water activity and are suitable for transport and storage[4]. Hence spray drying of beetroot juice may be a good alternative to use its health loving components available throughout the season[1]. The present investigation has planned with the objective to evaluate the physico-chemical properties of developed powder.

Materials and Methods

Fresh matured and uniform sizes of round shaped beetroots were selected washed and cleaned properly to remove foreign materials. Then the skin of beet juice was peeled manually by knives. The peeled beet roots were sliced. The grinding was done to extract the maximum amount of useful components from the beet root and subjected to get clear juice. The recovery of juice was around 55-60% of the fresh weight of beet roots.

Spray drying of Beet root juice

The extracted beet root juice was filtered with the help of muslin cloth. Soluble starch used as a drying agent (carrier) was procured from a local supplier. To spray drying process, a sample of 500g was taken. The beet root juice with carrier agent slurry of pre-determined concentration was stirred well, filtered through muslin cloth. The Beet root juice slurries were dried in SMST lab model spray dryer. To achieve best quality product, the spray dryer was operated at predetermined, experimental plan consisted with carrier agent soluble starch at processing temperature of 150^0C, 160^0C, 170^0C with feed flow rate 10ml/minute (fixed for all combinations as given in Table-1.The spray dried beetroot powder was collected from stainless steel cyclone in a glass jar.

Physical properties of spray dried beet root powder

Physical properties of estimated as per standard method detail as follows

Moisture content: The moisture content in the product was estimated according to the method of AOAC (1984).

Hunter Colour measurement: Colour is one of the major aspects of quality and acceptability of any food product. The Hunter Lab colorimeter (Model: Colour flex) was used for measuring the colour in terms of lightness (L*-value), redness (a*-value) and yellowness (b*-value) of stored spray dried beetroot powder. L* is a measure of the brightness from black (0) to white (100). Parameter a* describes red green colour with positive a* values indicating redness and negative a* values indicating greenness. Parameter b* describes yellow-blue colour with positive b*values indicating yellowness and negative b*-values indicating blueness. Prior to colour measurement, the colorimeter was calibrated to a standard black glass and standard white tile.

pH: The pH of the product was measured using digital pH meter with glass electrode. The sample was diluted in the ratio of 1:2, i.e. 5 g of sample was diluted with 10 ml of distilled water.

Bulk Density: Bulk density (g/mL) was determined by adding 2 g of powder into an empty 10 mL graduated cylinder. The ratio of powder mass and the volume occupied in the cylinder determines the bulk density value[3].

Solubility Index: The solubility of the beetroot powder was determined by the standard procedure.

Carbohydrates: Total carbohydrates in the product were estimated by hydrolysis method.

Protein: The protein content in the product was determined by using conventional micro-Kjeldahl digestion and distillation procedure using Pelican's Kel Plus digestion and distillation method.

Fat: The fat content of the product was determined by the procedure using pelican's socs plus automatic fat analysis system

Ash: The ash content in the product was determined by standard procedure.

Estimation of Minerals

The product Samples were prepared by wet digestion method in which 0.5 gm of sample which was moisture free was taken in the conical flask and 25 ml of diacid (nitric acid : perchloric acid in 5:1 v/v) was added to each sample. Samples were digested on hot plate till 1ml volume is left and colourless. Then volume was made to 100 ml and after it was filtered through whatman no. 41 filter paper. Representative sample in a suitable liquid form is sprayed into the flame of an atomic absorption spectrophotometer and the absorption or emission of the mineral to be analysed was measured at a specific wavelength. Minerals to be analysed were:

Minerals	Wavelength (nm)
1. Ca	422.7
2. Iron	248.3
3. Mg	285.2
4. Zn	213.9

Total soluble solids of fresh juice powder

The value of total soluble solids (TSS) of fresh juices powder were determined using a hand refractometer (Make: ERMA; Range: 0-32 °Brix) (Fig 3.2). The sample was thoroughly mixed and a small quantity of the test solution (2-3 drops) was put on the fixed prism of the refractometer and the movable prism was immediately adjusted. The field of view was suitably illuminated. The line dividing the light and dark parts of the surface in the field of view to the crossing of the threads was noted and the value of refractive index was measured.

Statistical analysis

The data obtained from various experiments were statistically analyzed. A complete randomized design was adopted for statistical analysis.

Results and Discussion

Table 1 Different combination of inlet temperature and soluble starch concentration

S. No	Treatment combinations	Temperature (^{0}C)	Soluble starch (%)
1.	T_1S_1	150	2.5
2.	T_2S_1	160	2.5
3.	T_3S_1	170	2.5
4.	T_1S_2	150	5
5.	T_2S_2	160	5
6.	T_3S_2	170	5
7.	T_1S_3	150	7.5
8.	T_2S_3	160	7.5
9.	T_3S_3	170	7.5

Note: Feed flow rate 10ml/minute. (Fixed for all combinations)

Moisture content: The effect of temperature and carrier combination on moisture in beetroot powder varied from 4.78 to 6.35 percent. The results indicated that increasing inlet air temperature and carrier significant effect on moisture loss[2].

pH: The rehydration of spray dried beetroot powder no major different of pH were determined in different carrier concentration 6.2 to 6.35. pH, were not significantly influenced by the spray drying conditions.

Table 2 Physical properties of developed spray dried beet root powder

S. No.	Treatment	Moisture (%)	TSS (°Brix)	pH	Bulk Density (g/ml)	Solubility index (%)
1.	T_1S_1	6.35	10.52	6.3	0.598	92.5
2.	T_2S_1	6.22	11.23	6.3	0.575	92.6
3.	T_3S_1	5.11	11.20	6.2	0.564	92.9
4.	T_1S_2	6.20	13.43	6.35	0.580	93.2
5.	T_2S_2	5.05	13.2	6.3	0.565	93.5
6.	T_3S_2	5.94	13.18	6.20	0.550	93.8
7.	T_1S_3	4.87	13.75	6.3	0.572	96.3
8.	T_2S_3	4.82	13.8	6.25	0.549	96.9
9.	T_3S_3	4.78	13.83	6.20	0.534	96.9

Bulk density

As per from table 2 observed from 0.534 to 0.598 the value observed the spray drying process for beetroot juice values for bulk density 0.62 g/ml. An increase in inlet air temperature caused a significant reduction in the bulk density of the beetroot powders due to increased evaporation rate which led to porous or fragmented structure and lowered the shrinkage of the droplets.

Total soluble solid (TSS):

It was observed that with increase in carrier concentration, TSS also increased. A set range of concentration temperature and concentration carrier was concerning that TSS of beetroot juice powder was determined from 10.52 to 13.83. The same condition was observed in spray dried orange juice powder[2].

Table 3 Colour analysis of developed spray dried beet root powder

S. No.	Treatment	Hunter color value		
		L* (Lightness)	a* (Redness)	b* (Yellowness)
1.	T_1S_1	71.70	9.83	12.34
2.	T_2S_1	71.30	9.20	13.20
3.	T_3S_1	71.21	9.15	13.32
4.	T_1S_2	70.27	9.20	12.40
5.	T_2S_2	70.20	9.15	14.59
6.	T_3S_2	70.15	8.10	15.10
7.	T_1S_3	70.69	8.58	14.75
8.	T_2S_3	70.80	8.85	16.02
9.	T_3S_3	70.15	8.32	16.25

Hunter color analysis: From table 3 the highest lightness L* value (71.7) showed by T_1S_1 formulation and lowest value (70.15) exhibited by T_3S_3 formulation. Highest a* value (9.83) scored by T_1S_1 formulation and lowest score (8.32) showed by T_3S_3 formulation. In case of b* values, T_1S_1 formulation showed highest value (16.25) while T_3S_3 formulation showed lowest value (12.34). The results show that increasing in temperature and carrier concentration the redness of powder is decrease. Similar findings of colour effect of Process Conditions on the Physicochemical Properties of Fermented Beet Root Juice Powder Produced by Spray Drying.

Table 4 Chemical analysis of developed spray dried beet root powder

S.No.	Treatment	Carbohydrate (g/100g)	Protein (g/100g)	Fat (g/100g)	Ash (g/100g)
1.	T_1S_1	83.56	9.34	1.05	1.70
2.	T_2S_1	83.64	9.15	1.01	1.70
3.	T_3S_1	83.80	9.09	0.9	1.70
4.	T_1S_2	82.77	8.52	1.01	1.81
5.	T_2S_2	83.82	8.45	0.9	1.81
6.	T_3S_2	82.84	8.32	0.8	1.82
7.	T_1S_3	84.50	7.87	0.9	2.21
8.	T_2S_3	84.55	7.45	0.9	2.21
9.	T_3S_3	84.60	7.43	0.7	2.22
SEM		0.129	0.086	0.079	0.098
CD @ 5%		0.367	0.306	0.383	0.290

The Chemical analysis of developed spray dried beet root powder of different treatment the carbohydrate ranged between 83.56 to 84.60 g/100g. Protein content of reported from 7.43 to 9.34 g/100g. Fat varies between 0.7 to 1.05 g/100g .Ash content with carrier of soluble starch were observed to have ash content between 1.70 to 2.22 g/100g.

Table 5 Mineral content of developed spray dried beet root powder

S. No.	Treatment	Iron (mg/100g)	Calcium (mg/100)	Zinc (mg/100)	magnesium (mg/100g)
1.	T_1S_1	1.79	14.2	0.24	23.2
2.	T_2S_1	1.79	14.1	0.22	23.3
3.	T_3S_1	1.75	14.3	0.20	23.7
4.	T_1S_2	1.80	13.7	0.22	23.1
5.	T_2S_2	1.80	13.4	0.20	21.1
6.	T_3S_2	1.72	13.2	0.19	21.5
7.	T_1S_3	1.76	13.8	0.23	20.9
8.	T_2S_3	1.70	13.2	0.20	20.2
9.	T_3S_3	1.70	13.1	0.18	20.5
	SEM	0.047	0.096	0.083	0.097
	CD @ 5%	0.327	0.306	0.283	0.297

From table 5 soluble starch concentrated treatment iron content was ranged from 1.70 to 1.79 mg/100g, zinc between 0.18 to 0.24 mg/100g, calcium from 14.2 to 15.4 mg/100g and magnesium was exhibited from 20.5 to 23.2 mg/100g. The beetroot powder content higher chemical value as compare to row beetroot because the water present in beetroot is removed and concentrated powder obtained by the spray drying. Similar results were reported Nemzer, B. et al. (2011) the spray dried beetroot extract.

Table 6 Sensory analysis of spray dried beetroot powder.

Treatment	Colour & Appearance	Aroma	Mouth feel	Texture	Overall Acceptability
T_1S_1	**5.5**	**5.7**	**5.6**	**6.3**	**6.1**
T_2S_1	6.0	6.8	6.9	6.4	6.9
T_3S_1	6.7	6.8	6.9	6.6	6.8
T_1S_2	6.6	6.1	6.7	6.8	7.0
T_2S_2	6.5	6.3	6.8	6.9	6.8
T_3S_2	7.5	7.3	6.1	7.3	7.4
T_1S_3	7.9	7.5	6.3	7.1	7.3
T_2S_3	7.8	7.6	7.2	7.5	7.6
T_3S_3	**8.0**	**8.5**	**8.2**	**8.1**	**8.3**

Sensory analysis of spray dried beetroot powder

Sensory analysis of Treatment combinations after spray drying of beetroot powder done by using nine point hedonic rating scale which was vary from " Extremely like" on point 9 and " Extremely dislike" on point 1. Sensory evaluation parameters in booths under were color & appearance, aroma, mouth feel, texture and overall acceptability. Tasters were instructed to evaluate each sample individually. As can be seen from the table-6 in case of temperature (^{0}C) with soluble starch (%) treatment combinations sensory analysis revealed that the T_3S_3 product exhibited best score among the modified for color & appearance, aroma, mouth feel, Texture and overall acceptability respectively. The product T_3S_3 got 8.0, 8.5, 8.2, 8.1 & 8.3 for the same sensory parameters whereas T_1S_1 product got the lowest overall acceptability as 6.1. A significant difference was observed between the treatments. According to pinki (2014) stated that Increasing of temperature and carrier concentration significant effect on quality of powder.

Conclusion

Development and optimization of beet root powders are essential to select appropriate method and machine, optimum processes, functionality, and the formulation. Hence, characterized powders articulated with beetroot (*Beta vulgaris*) juice concentrate will be helpful in the attainment of a product which will be containing all functional health benefits that are associated with this vegetable. In present study It could be concluded that the best quality spray dried beetroot powder (T_3S_3) produce at temperature 170^{0}C, soluble starch concentration 7.5%

with feed flow rate 10ml/minute. It is inferred from above findings that best acceptable product can be developed using above given parameter at house hold level and commercial scale

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